HSMx-A101

Surface Mount LED Indicator

Reliability Data Sheet

Description

The following cumulative test results have been obtained from testing performed at Avago Technologies in accordance with the latest revision of MIL-STD-883.

Avago tests parts at the absolute maximum rated conditions recommended for the device. The actual performance you obtain from Avago parts depends on the electrical and environmental characteristics of your application but will probably be better than the performance outlined in Table 1.

Table 1. Life Tests
Demonstrated Performance

					Point Typical Performance	
Colors	Stress Test Conditions	Total Device Hrs.	Units Tested	Units Failed	MTBF	Failure Rate (% / 1K Hours)
InGaN	T_A = 55°C, If = 20 mA	84,000	84	0	84,000	≤1.19
InGaN	T_A = -40°C, If = 30 mA	84,000	84	0	84,000	≤1.19
InGaN	T_A = 85°C, 85% RH, If = 10 mA	84,000	84	0	84,000	≤1.19
AlInGaP, AlGaAs	T_A = 55°C, If = 30 mA	84,000	84	0	84,000	≤1.19
AlInGaP, AlGaAs	T_A = -40°C, If = 30 mA	84,000	84	0	84,000	≤1.19
AlInGaP, AlGaAs	T_A = 85°C, 85% RH, If = 20 mA	84,000	84	0	84,000	≤1.19
GaP,	T_A = 55°C, If = 30 mA	84,000	84	0	84,000	≤1.19
GaP,	T_A = -40°C, If = 30 mA	84,000	84	0	84,000	≤1.19
GaP,	T_A = 85°C, 85% RH, If = 20 mA	84,000	84	0	84,000	≤1.19

Failure Rate Prediction

The failure rate of semiconductor devices is determined by the junction temperature of the device. The relationship between ambient temperature and actual junction temperature is given by the following:

$$T_J\ (°C) = T_A\ (°C) + \theta_{JA}\ P_{AVG}$$

where

T_A = ambient temperature in (°C)

θ_{JA} = thermal resistance of junction-to-ambient in °C/watt

P_{AVG} = average power dissipated in watts

The estimated MTBF and failure rate at temperatures lower than the actual stress temperature can be determined by using an Arrhenius model for temperature acceleration. Results of such calculations are shown in the table below using an activation energy of 0.43 eV (reference MIL-HDBK-217).

Table 2. Reliability Predictions

InGaN (If = 20 mA)

		Point Typical Performance in Time[1] (60% Confidence)		Performance in Time[2] (90% Confidence)	
Ambient Temperature (°C)	**Junction Temperature (°C)**	**MTBF[1]**	**Failure Rate (% / 1K Hours)**	**MTBF[2]**	**Failure Rate (% / 1K Hours)**
95	189	30,000	3.314	13,000	7.630
85	179	38,000	2.609	17,000	6.008
75	169	49,000	2.033	21,000	4.680
65	159	64,000	1.565	28,000	3.604
55	149	84,000	1.190	36,000	2.741
45	139	112,000	0.893	49,000	2.057
35	129	151,000	0.661	66,000	1.522
25	119	208,000	0.482	90,000	1.109

AlInGaP / AlGaAs (If = 30 mA)

		Point Typical Performance in Time[1] (60% Confidence)		Performance in Time[2] (90% Confidence)	
Ambient Temperature (°C)	**Junction Temperature (°C)**	**MTBF[1]**	**Failure Rate (% / 1K Hours)**	**MTBF[2]**	**Failure Rate (% / 1K Hours)**
95	179	29,000	3.485	12,000	8.025
85	169	37,000	2.714	16,000	6.248
75	159	48,000	2.088	21,000	4.808
65	149	63,000	1.587	27,000	3.655
55	139	84,000	1.190	36,000	2.741
45	129	114,000	0.880	49,000	2.027
35	119	156,000	0.641	68,000	1.475
25	109	218,000	0.459	95,000	1.056

GaP (If = 30 mA)

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance in Time[1] (60% Confidence) MTBF[1]	Failure Rate (% / 1K Hours)	Performance in Time[2] (90% Confidence) MTBF[2]	Failure Rate (% / 1K Hours)
95	183	29,000	3.409	13,000	7.850
85	173	37,000	2.668	16,000	6.142
75	163	48,000	2.064	21,000	4.752
65	153	63,000	1.578	28,000	3.632
55	143	84,000	1.190	36,000	2.741
45	133	113,000	0.886	49,000	2.040
35	123	154,000	0.650	67,000	1.496
25	113	213,000	0.469	93,000	1.079

Notes:

1. The point typical MTBF (which represents 60% confidence level) is the total device hours divided by the number of failures. In the case of zero failure, one failure is assumed for this calculation.
2. The 90% Confidence MTBF represents the minimum level of reliability performance which is expected from 90% of all samples. This confidence interval is based on the statistics of the distribution of failures is exponential. This particular distribution is commonly used in describing useful life failures. Refer to MIL-STD-690B for details on this methodology.
3. A failure is any LED which is open, shorted, or failed to emit light.
4. Calculated from data generated at 55°C biased at 50 mA.

Example of Failure Rate Calculation

Assume a device operating 8 hours/day, 5 days/week. The utilization factor, given 168 hours/week is:

(8 hours/day) x (5 days/week) / (168 hours/week) = 0.25

The point failure rate per year (8760 hours) at 55℃ ambient temperature is:

(0.033% /1K hours) x (0.25) x (8760 hours/year) = 0.072% per year

Similarly, 90% confidence level failure rate per year at 55℃:

(0.129% /1K hours) x 0.25 x (8760 hours/year) = 0.283% per year.

Table 3. Environmental Tests

Test	Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	Avago Req.	-55/100°C 15 min dwell 5 min. transfer, 100 cycles	5000	0
Resistence to Soldering Heat	MIL-Std-883 Ref. 2003	260°C for 10 seconds	72	0
Solderability	MIL-STD-883 Ref.2003	240°C for 5 seconds, >95% solder coverage of lead	22	0
Pulse Test	Avago Req.	T_A = 25°C, Duty Factor = 10%, 100 mA Freq = 1 kHz, 1000 hours	252	0
Temperature Shock	Avago Req.	-55/100°C, 30 min dwell, <0 sec transfer, 100 cycles	500	0
Temperature Humidity Cycle	MIL-STD-883 Ref. 1004	-10°C to 65°C, 90-98% RH 50 cycles	385	0
High Temperature Storage	MIL-STD-883 Ref. 1005	85°C for 1000 hours	693	0
Moisture Sensitivity Test	EIA/JESD 22-A112-A, Level 2a		28	0
ESD	HBM: EIA/JESD 22-A114-A- Class 2 MM: EIA/JESD 22-A115-A- Class C		10	0

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5988-9275EN July 9, 2006